REMARKS

Please reconsider the application in view of the above amendments and the following remarks. Applicant thanks the Examiner for carefully considering this application.

Preliminary Matters

Applicant provides a copy of the requested document, GB1417553.

Pursuant to a substitute Power of Attorney filed herewith, please change the attorney docket number to **09428/113002** and send future communications to the address associated with customer number **55346**.

Disposition of Claims

Claims 1-36 are pending in this application. Claims 1 and 19 are independent claims.

Claims 2-18 depend, directly or indirectly, from claim 1 and claims 20-36 depend, directly or indirectly, from claim 19.

Claim Amendments

Claims 1, 4, 6, 13, 15, 18, 19, 22, 24, 31, 33, and 36 have been amended to recite a "plurality of layers" rather than "at least one layer." No new matter is introduced by this amendment.

Claims 17 and 18 were amended to correct improper dependencies. No new matter is introduced by these amendments.

Objections to the drawings

Paragraphs 51 and 59 of the specification have been amended, as outlined above. The description now makes specific references to label 900 in Figure 6 and to label 1100 in Figure 11. Accordingly, withdrawal of this objection is respectfully requested.

Rejections under 35 U.S.C. §112, first paragraph

Claims 17 and 18 were rejected under 35 U.S.C. 112, 2nd paragraph as being indefinite. The indefinite nature of the claims and their subsequent interpretation was due to improper claim dependency. This has been corrected by way of amendments to these claims. Accordingly, withdrawal of this rejection is respectfully requested.

Rejection(s) under 35 U.S.C. §102(b)

Claims 1-8, 11-12, 19-26, 29-30 were rejected under 35 U.S.C. §102(b) as being anticipated by Plumb et al., U.S. Patent No. 6,078,867. To the extent that this rejection may still apply to the amended claims, this rejection is respectfully traversed.

Independent claims 1 and 19 recite displaying a plurality of well bore measurement data as a *plurality* of layers overlaying the borehole model. The layers may be concentrically disposed about the borehole, and multiple layers may be simultaneously displayed as shown in Figure 11 (page 5, paragraph [0059])[1], for example.

While Plumb does disclose projecting a plurality of data on a well bore model, Plumb discloses projecting the data only as a *single* layer on the borehole surface model, not as multiple

[1]The paragraph numbering refers to that in the U.S. Patent Application Publication US2004/0204855 A1

layers as presented in the current invention. For example, the color mapping onto the borehole model disclosed by Plumb (column 2, lines 20-22 and column 4, lines 45-50) is carried out on a single layer bore hole surface model.

To anticipate a claim, the cited reference must teach each and every limitation of the claim. Because Plumb et al. fails to teach or suggest at least one limitation of claims 1 and 19 (i.e., *displaying the plurality of measurement data as a plurality of layers overlaying the borehole model*), claims 1 and 19 are patentable over Plumb et al. Dependent claims 2-8, 11-12, 20-26 and 29-30 should also be patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

Rejection(s) under 35 U.S.C. §103

Claims 9, 10, 27, and 28

Claims 9, 10, 27, and 28 were rejected under 35 U.S.C. §103(a) as being unpatentable over Plumb et al. in view of Austin, "Application of 3D Visualization Software to Reservoir Simulation Post-Processing", SPE 24433, 1992.

Claims 9-10 and 27-28 depend from claims 1 and 19. As noted above, Plumb et al. fails to teach or suggest at least one limitation of claims 1 and 19 (i.e., *displaying the plurality of measurement data as a plurality of layers overlaying the borehole model*). Austin does not teach or suggest that which Plumb et al. lacks, as evidenced by the fact that the Examiner relied upon Austin for the teaching of displaying a measurement value associated with a cursor location. (Office Action, p. 6, paragraphs 22-23).

Therefore, Plumb et al. and Austin, whether considered separately or in combination, cannot teach or suggest each and every limitation of independent claims 1 and 19. Thus, claims 1 and 19 are patentable over Plumb et al. in view of Austin. Dependent claims 9, 10, 27, and 28 should also be patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

Claims 13-15 and 31-33

Claims 13-15 and 31-33 were rejected under 35 U.S.C. §103(a) as being unpatentable over Plumb et al. in view of Rice, U.S. Patent No. 4,467,461. To the extent that this rejection may still apply to the amended claims, this rejection is respectfully traversed.

Claims 13-15 and 31-33 depend from claims 1 and 19. As noted above, Plumb et al. fails to teach or suggest at least one limitation of claims 1 and 19 (i.e., *displaying the plurality of measurement data as a plurality of layers overlaying the borehole model*). Rice does not teach or suggest that which Plumb et al. lacks, as evidenced by the fact that the Examiner relied upon Rice for the teaching of 3D cut or cross-sections. (Office Action, p. 8, paragraph 29).

Therefore, Plumb et al. and Rice, whether considered separately or in combination, cannot teach or suggest each and every limitation of independent claims 1 and 19. Thus, claims 1 and 19 are patentable over Plumb et al. in view of Austin. Dependent claims 13-15, and 31-33 should also be patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

Claims 16-18 and 34-36

Claims 16-18 and 34-36 were rejected under 35 U.S.C. §103(a) as being unpatentable over Plumb et al. in view of Bryant et al. "Reservoir Description for Optimal Placement of Horizontal Wells", SPE 35521, 1996. To the extent that this rejection may still apply to the amended claims, this rejection is respectfully traversed.

Claims 16-18 and 34-36 depend from claims 1 and 19. As noted above, Plumb et al. fails to teach or suggest at least one limitation of claims 1 and 19 (i.e., *displaying the plurality of measurement data as a plurality of layers overlaying the borehole model*). The Bryant et al. paper does not teach or suggest that which Plumb et al. lacks, as evidenced by the fact that the Examiner relied upon the Bryant et al. paper for the teaching of displaying dip planes. (Office Action, p. 9, paragraph 35).

Therefore, Plumb et al. and Bryant et al., whether considered separately or in combination, cannot teach or suggest each and every limitation of independent claims 1 and 19. Thus, claims 1 and 19 are patentable over Plumb et al. in view of Austin. Dependent claims 16-18, and 34-36 should also be patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

Conclusion

Applicant believes this reply is fully responsive to all outstanding issues and places this application in condition for allowance. If this belief is incorrect, or other issues arise, the Examiner is encouraged to contact the undersigned or his associates at the telephone number listed below. Please apply any charges not covered, or any credits, to Deposit Account 50-0591 (Reference Number 07200/036001).

Dated: September 20, 2006

Respectfully submitted,

By _____

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PATENT SPECIFICATION (11) 1417553

1417553

(21) Application No. 29624/75 (22) Filed 28 Oct. 1971
(21) Application No. 29625/75 (22) Filed 10 Nov. 1971
(21) Application No. 29626/75 (22) Filed 20 Dec. 1971
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H4D G2 G3C G3P G3R G4A5 G7P
G1J 2A2A 2A2C 2D2 2E 2F
G1N 257 258 693

(72) Inventor NIGEL ALLISTER ANSTEY

(54) A METHOD(OF DISPLAYING GEOPHYSICAL VARIABLES

(71) We, SEISCOM LIMITED, a British company of Tubs Hill House, Sevenoaks, Kent, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of displaying geophysical variables.

The invention is concerned with the combined display in colour, for visual appraisal, of quantities which are different functions of the same variable.

Useful information can often be obtained by bringing together the variations of more than one quantity as a function of a common variable. One example is in siesmic exploration, where the geological value of the conventional display of siesmic vibrations as a function of reflection times may be enhanced by adding to the display further variables (such as interval velocity). Other examples include: (a) the interpretation as a function of depth of acoustic, electric, neutron or other logs taken in a borehole; (b) the interpretation of gravity and magnetic field readings taken as a function of distance along a profile.

Where the nature of the expected relationship between several functions can be expressed mathematically, it is usual to employ the techniques of cross-correlation to obtain a numerical measure of this relationship. In appropriate applications, these techniques are very powerful, being able to find relationships between functions when such relationships cannot be detected by visual examination of the corresponding waveforms. However, cross-correlation techniques are better than the eye only if the integration intervals are long enough to include many cycles of variations and if there is no significant stretch of compression of the common-variable axis.

Further, there remains a place for visual correlation in every case where a skilled human judgement must be made on the significance of the correlation, and where this skill has not yet advanced to the stage where its basis for judgment can be quantified; such situations exist in the aforementioned examples of geology and log analysis.

The terms "variable-area" and "variable-density" as used below are used in the sense established in the technology of the optical recording of sound on film: a "variable-area" track or trace is one in which the black area of a partly-black-partly-white trace is modulated in accordance with the dependent variable; and a "variable-density" track or trace is one in which the grey density of a constant-width trace is so modulated.

The present invention is concerned with a method of forming a display of a plurality of geophysical functions measured along a line of profile or in a borehole, which comprises:

(a) establishing a trace whose length represents distance along the profile or depth in the borehole,

(b) representing a first said geophysical function by modulation of the density of a first colour applied to the trace,

(c) representing a second said geophysical function by modulation of the density of a second colour applied in super-imposition to the first colour, and

(d) representing at least one further said geophysical function by modulation of the density of at least one respective further colour applied in superimposition to the first and second colours,

Displays formed by the above method convey to the eye, very quickly and easily, information on various types of relationship which may exist between the several geophysical variables.

In a further embodiment, a further geo-

physical function may be represented by a variable area or variable density trace which is superimposed on the coloured trace.

Co-pending application No. 49471/72 (Serial No. 1,417,552) is concerned with waveform display in colour.

The invention is now described with reference to the accompanying drawings, in which:

Figure 1 shows three functions of the same variable together with their separate and combined representations as coloured traces.

Figure 2 shows, in block-diagram form, the stages of operating on three input functions to make one or more coloured traces, and the manner of superimposing a fourth function in variable-area form.

Figure 3 shows how the plotting operations of Figure 2 may be accomplished simultaneously, using a colour cathode-ray-tube.

Figure 4 shows how the plotting and printing operations of Figure 2 may be accomplished simultaneously, using three modulatable light sources of distinctive colours and colour photographic material.

Figure 5a shows how the plotting operations of Figure 2 may be accomplished sequentially using a single modulatable light source and black-and-white photographic material; Figures 5b and 5c show two variations on the colour printing operation which may be associated with Figure 5a.

Figures 6a, 6b and 6c are representations of three films showing different coloured traces.

Figure 1 illustrates one type of display provided by the invention. Three functions of the same variable are shown at 1, 2 and 3, respectively: these represent for example, different physical measurements conducted in a borehole at different depths. Each such function is plotted as a variable-density trace of a distinctive colour. As suppested at 4, the trace corresponding to function 1 is displayed in shades of red; three densities of red are used to represent the three levels present in the function 1, and these three densities are given the values "0", "1" and "2", respectively. Similarly, the second function 2 is represented in Figure 1 as a trace 5 exhibiting three density levels of green, and the third function 3 as a trace 6 exhibiting three density levels of blue. The three traces may be of equal width, and plotted to the same scale of the independent (vertical) variable; the three colours are selected as being distinctive, and may be the primary colours, their complements, or any other suitable hues. These three traces are superposed upon one another to yield a composite trace 7. This trace exhibits colour variations, as indicated, which represent and identify particular combinations of values for the three contributory functions: 1, 2 and 3, respectively. Such a display is of great value for the visual identification of particular borehole conditions which may be detected only as a combination of several effects.

Figure 2 illustrates the techniques appropriate to producing the display of Figure 1. In this figure, the three variable functions 1, 2 and 3 are assumed recorded on three tapes 32, 33 and 34, respectively, from which they may be called out on demand. At 35, they are then suitably processed (for example, filtered) according to techniques well known in the art, and then scaled and produced in a format appropriate to the type of plotter to be used. The plotting stage 36 allows the superposition of light of three distinctive colours (the intensity of each colour being related to the original variables 32—34) and the recording of the superposition of these three colours on the colour print 37.

Figure 3 illustrates generally how the plotting stage 36 may be accomplished by means of a conventional colour cathode-ray tube 38. The three plot signals 39—41 correspond to the output of the formatting stages 35 in Figure 2. The final colour print 37 may be made by contact exposure on the face of the cathode-ray tube (for which purpose the faceplate of the tube is preferably of the fibre-optic type), or by standard photographic techniques using a conventional camera 42.

Figure 4 illustrates generally how the plotting stage 36 may be accomplished by the modulation of three sources of coloured light. For example, these sources may be lasers 43—45 (each of distinctive colour) followed by Pockel-cell modulators 46—48; thereafter, the three light beams may be combined in a lens 49 and focused on to a colour film 50. The representation of the independent variable is then by motion of the combined light image 51 relative to the film 50; this may be achieved by scanning of the image across a stationary film by means of moving mirrors (not shown) or by movement of the film 50 by means of the traversing mechanism shown generally at 52. The combination of laser and modulator may be replaced by alternative sources of light, e.g. glow-modulators, incandescent lamps and light-emitting diodes, and these may be used in combination with optical filters to improve the separation of the colours.

Figure 5a illustrates generally how the plotting stage 36 may be accomplished by the sequential use of a single modulatable light source. The modulation apparatus 55 is connected to the three plot-control signals 39—41, in turn, as suggested by the switch 53. A separate variable-density trace is made on the monochrome film 57 (in combination with the optical system 56 and a traversing mechanism such as that illustrated at 52 in Figure 4), for each of the three plot-control signals. Each of the three traces is then

dyed in conventional manner (not shown) to a suitable distinctive colour.

Figure 5b shows three films 57a, 57b and 57c carrying the different coloured traces in registration in front of a white light source 58 and photographed by a conventional camera 42. The films with their different traces: yellow, cyan and magenta are shown as Figures 6a, 6b and 6c respectively.

Figure 5c is a variation on Figure 5b in that the final colour print 60 is made by three separate exposures, each with a distinctive colour of light. Light from the white light source 58 is filtered through an optical filter 59 and used to expose colour material 60 through the first monochrome film 57; subsequent exposures of the other two monochrome films 57, in registration, are made through different filters 59.

As mentioned above, the three colours employed may conveniently be the primary colours or their complements, according to the order and number of photographic processes and the final effect desired. In a preferred expression of the technique represented by Figures 2, 5a and 5c, the processing steps 35 include the complementation of the variable function (for example, by its subtraction from a fixed large number) so that the plot instructions 39—41 represent a negative photographic image. This may be illustrated by reference to a variable function 32, due to be represented by the intensity of red on the final print 37. The process of complementation means that a large value of the variable 32 is represented by an instruction 39 to plot at a light-grey density on monochrome film 57. The optical filter 59 Fig. 5c is then selected to be green-blue, so that intense green-blue light is transmitted through the light density of the film 57 to the colour print material 60.

This produces, after photographic processing, a major deposition of yellow and magenta dyes (and hence an intense red colouration) at the trace position appropriate to this large value of the variable 32. Correspondingly, a small value of the function 32 produces a dark-grey density on the film 57, a weak green-blue illumination of the print 60, and a weak red colouration on the processed print.

Equivalent processes are used for the function 33 (employing a red-green filter 59 and producing a blue image on the print 60) and for the function 34 (employing a red-blue filter 59 and producing a green image on the print 60). With this technique, a suitable material for the print 60 is Ektacolour RC37 (Registered Trade Mark), marketed by Kodak Limited.

It may be desired to superimpose a variable-area trace on the coloured trace, with the variable-area trace representing a fourth variable. In Figure 2, the steps corresponding to this additional input are shown dashed; the variable itself is derived from a storage medium 62, scaled and formatted at 35, and plotted in variable-area according to plot instructions 63. The variable-area film obtained from the plotter is used as a fourth stage in the above colour-printing sequence; the film in this fourth stage is used in conjunction with the white light 58, either with no filter at 59 or with a special filter matched to give a good black from the light 58 and the paper 60 in use.

Although the "red" exposure, the "blue" exposure, the "green" exposure and the variable-area "black" exposure have been described in that order, any other convenient and effective order may be used.

Also the fourth input to be superposed on the colour traces may be in variable-density instead of variable-area, with no change to the operational sequence described above.

In the sequence represented by Figures 2, 5a and 5c, the processing stage 35 is conveniently effected by a suitable digital computer and the plotting stage 36 is conveniently effected by the LGP 2703 Laser Graphic Plotter developed by SIE—Dresser Industries of Houston, Texas. This machine and others of similar type represent a preferred means of realising the plotting stage 36 since they allow accurate digital control of photographic densities.

In the digital plotter, a monochrome photographic film is exposed by a laser beam, which builds up a complete photographic picture as a matrix of small dots. The intensity of each dot is under digital control; a 4-bit word associated with each dot defines 16 tones from black through 14 shades of grey to white (or clear). The beam scan defines one dimension of the display (normally taken as that of the independent variable), while the indexing of the film between scans defines the other dimension.

It is possible to use the digital plotter to make variable-density seismic cross-sections by reducing the dynamic range of the normal reflection signal to 4 bits, by presenting each trace in turn to the computer controlling the plotter, and by building up the trace to the required width by making an appropriate number of identical scans.

Alternatively, the plotter may be used to make variable-area siesmic cross-sections by building up each trace as an appropriate number of different scans, the difference between scans being determined by a logical discrimination program designed to construct a variable-area trace in a step-wise manner. In this variable-area case, of course, only a single bit (rather than a 4-bit word) is required to define the condition of any dot on the scan.

In our copending Application No. 50199/71, (Serial No. 1,417,551) the use of the

digital plotter for the display of more than one variable function, in monochrome, is described in connection with seismic cross-sections. For example, the usual seismic vibration may be displayed as a variable-area trace, while a second numerical function (illustratively, a measure of the coherence between several samples of the vibration) is displayed as density variations in the "black" part of the variable-area trace.

In the present context, however, the digital plotter is used in a direct adaptation of the variable-area and variable-density plotting techniques described above. The three colour-plot signals 39—41 are used to make three separate variable-density traces (corresponding to traces 4—6 in Figure 1) by the techniques described above for making variable-density traces; likewise, there may be made a variable-density grey trace to be superimposed on the colour trace. Similarly, a variable-area black-clear trace may be superimposed on the colour trace.

WHAT WE CLAIM IS:—

1. A method of forming a display of a plurality of geophysical functions measured along a line of profile or in a borehole, which comprises:

(a) establishing a trace whose length dimension represents distance along the profile or depth in the borehole,

(b) representing a first said geophysical function by modulation of the density of a first colour applied to the trace,

(c) representing a second said geophysical function by modulation of the density of a second colour applied in superimposition to the first colour, and

(d) representing at least one further said geophysical function by modulation of the density of at least one respective further colour applied in superimposition to the first and second colours.

2. A method as claimed in claim 1 in which a further geophysical function is represented by a variable area or variable density trace which is superimposed on the coloured trace.

3. A method of forming a display of a plurality of geophysical functions as claimed in claim 1, substantially as hereindescribed with reference to the accompanying drawings.

4. A display when formed by a method as claimed in any of claims 1 to 3.

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Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1417553 COMPLETE SPECIFICATION
8 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

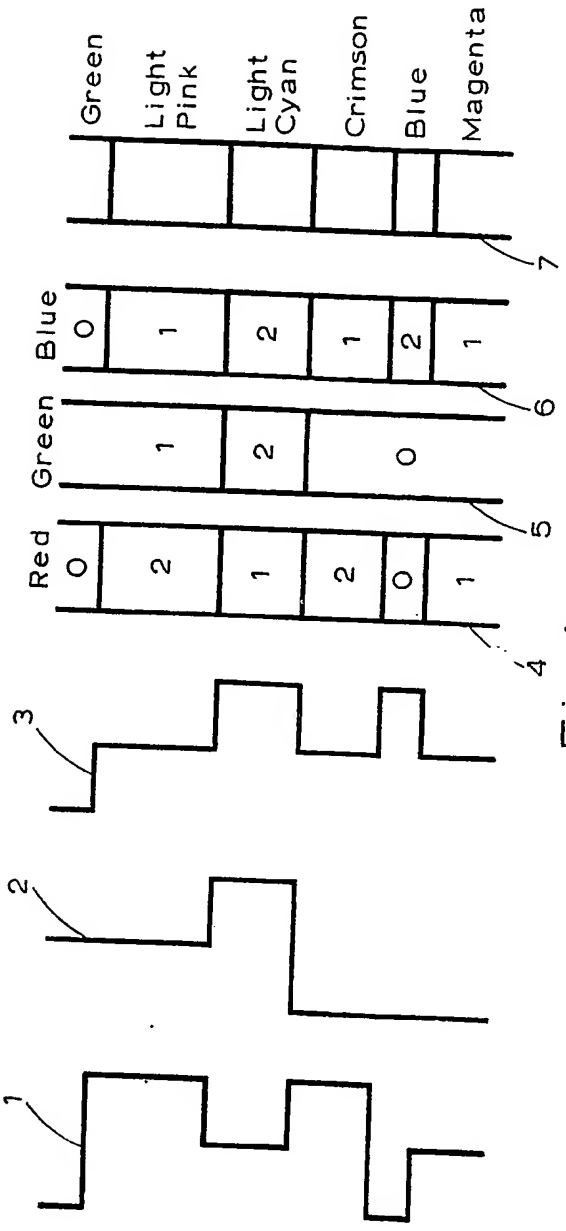
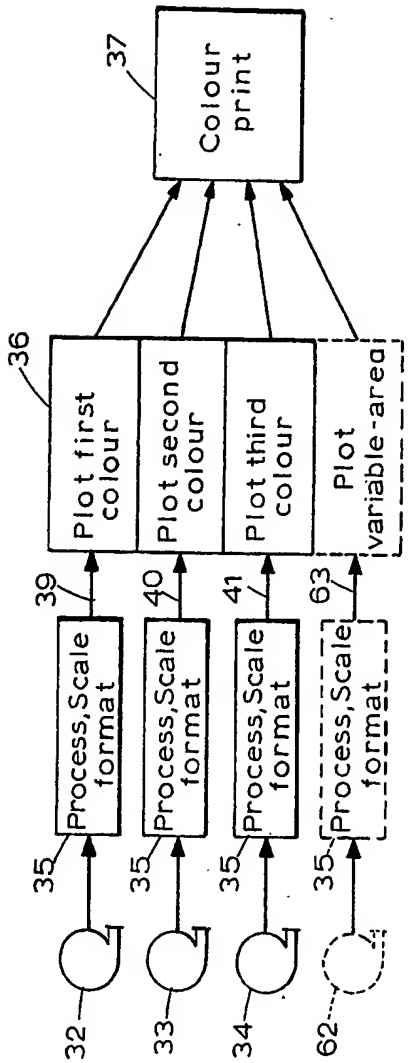


Fig.1.


37
Colour print
36
Plot first colour
Plot second colour
Plot third colour
Plot variable-area
39
40
41
63
Process, Scale format
Process, Scale format
Process, Scale format
Process, Scale format
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35
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32
33
34
62

Fig. 2.

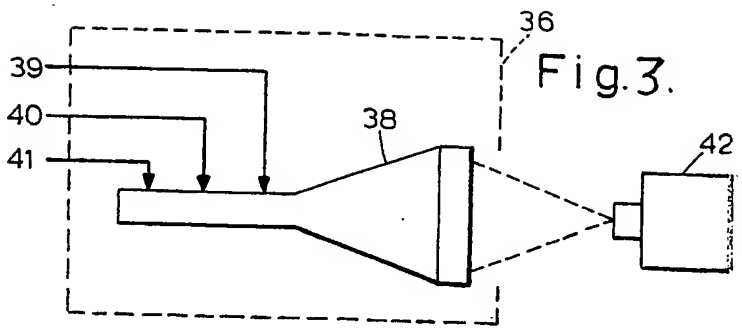
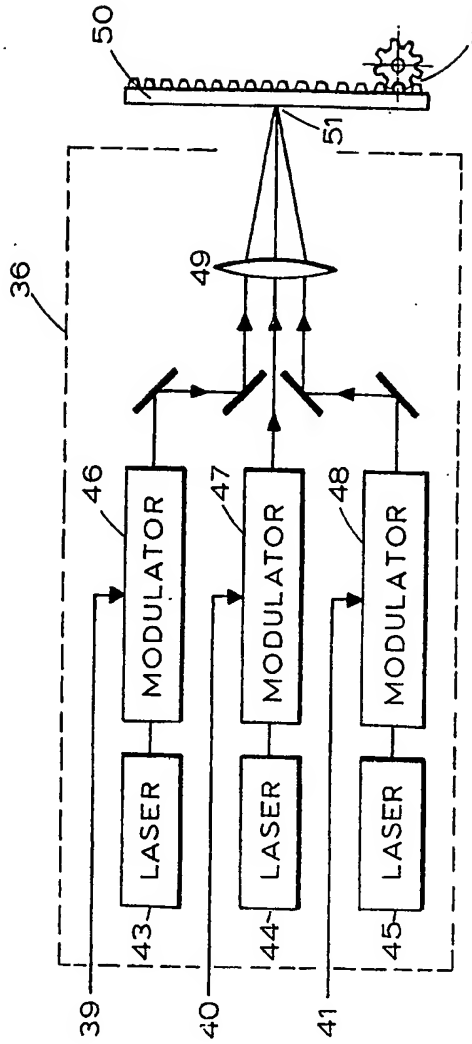


Fig.3.


50
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MODULATOR
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MODULATOR
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Fig. 4.

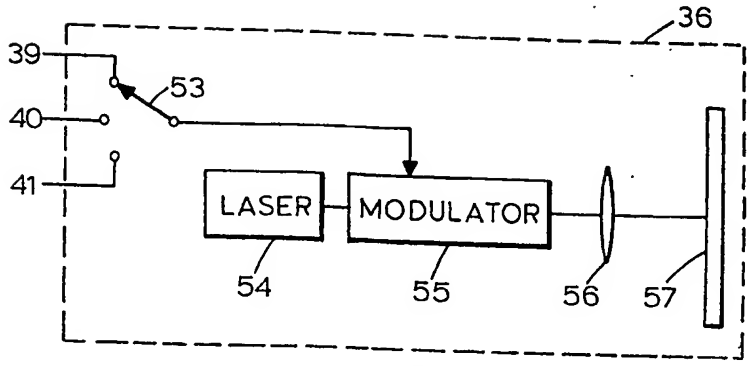

Fig.5a.

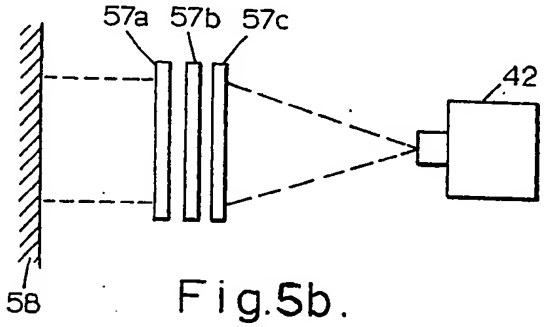

Fig.5b.

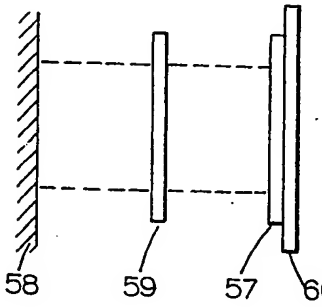

Fig.5c.

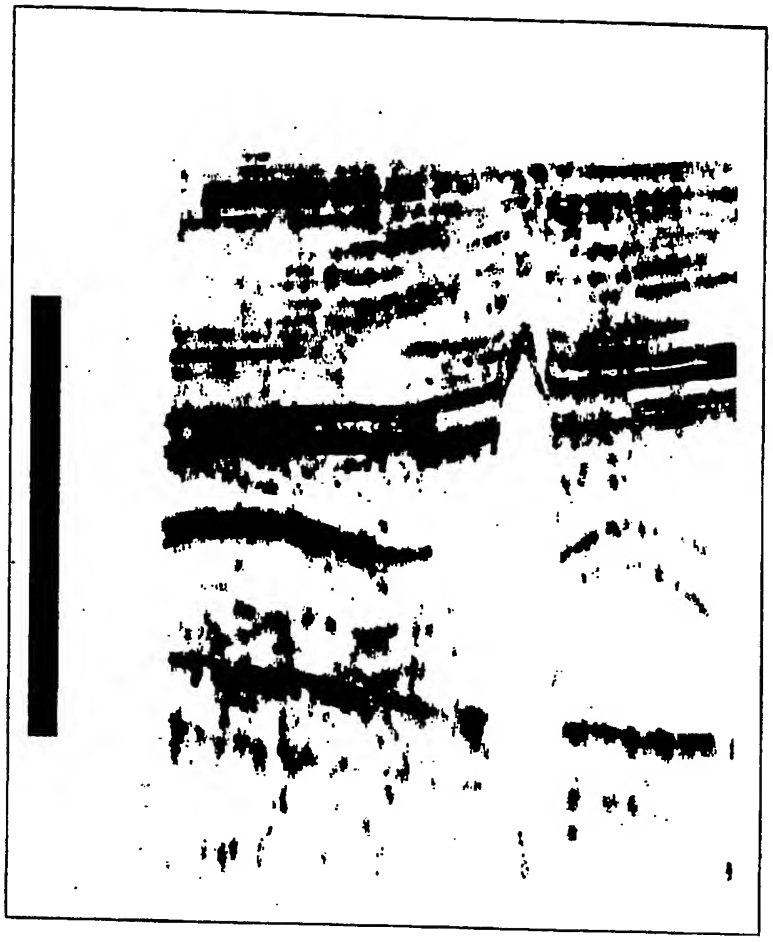

Fig. 6a.

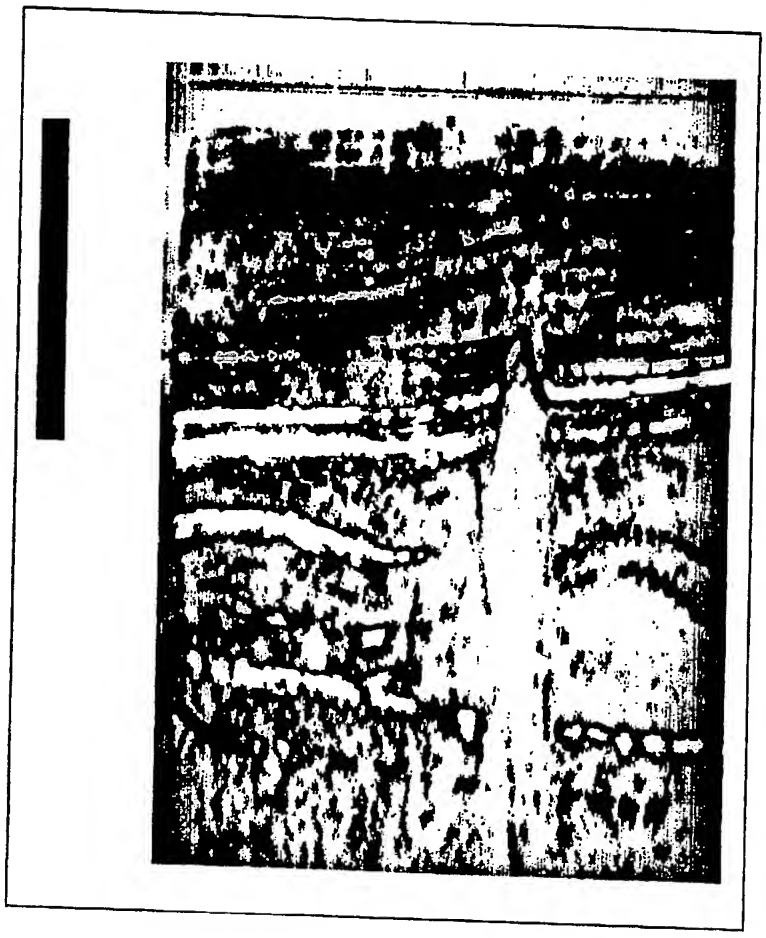

Fig. 6b.

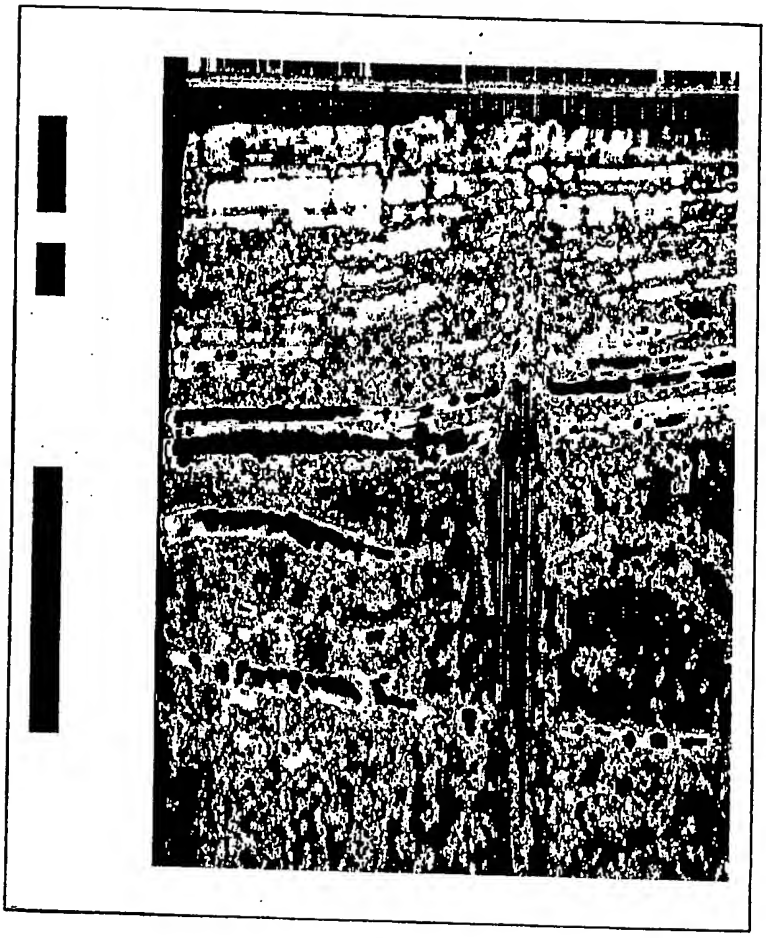

Fig. 6c.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Name of Assignee: SCHLUMBERGER TECHNOLOGY CORPORATION
Address of Applicant: 200 Gillingham Lane
Sugar Land, TX 77478

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

REVOCATION AND SUBSTITUTION OF POWER OF ATTORNEY UNDER 37 C.F.R. §1.36

Dear Sir:

Pursuant to 37 C.F.R. §1.36, Schlumberger Technology Corporation, the assignee of the patent applications listed on the attached APPENDIX A, revokes all previous powers of attorney in the patent applications listed on the attached APPENDIX A, hereby appoints the attorneys and/or agents assigned to the Customer Number listed below to prosecute the patent applications listed on the attached APPENDIX A, and to transact all business in the U.S. Patent and Trademark Office connected therewith:

Customer Number **55346**

Please direct all correspondence and telephone calls concerning the patent applications listed on the attached APPENDIX A to:

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Facsimile No.: (713) 228-8778

The undersigned representative of the above-identified assignee certifies that the above-identified assignee is the assignee of the entire right, title, and interest in the patent applications listed on the attached APPENDIX A by virtue of the chains of titles from the

inventors of the patent applications listed on the attached APPENDIX A to the above-identified assignee.

The undersigned (whose title is supplied below) is empowered to sign this certificate on behalf of the above-identified assignee.

The undersigned hereby declares that all statements made herein of the undersigned's own knowledge are true, that all statements made on information and belief are believed to be true, and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the patent applications listed on the attached APPENDIX A or any patents issuing thereon.

Signature: Brigitte L Echols Dated: 30 May 2006

Name: Brigitte L. Echols

Title: Attorney-In-Fact

Schlumberger Technology Corp.

APPENDIX A

1. **Patent Application/Serial No.:** 10/604,062
   Applicant(s): Simon Fleury et al.
   Title: System and Method for Visualizing Data in a Three-Dimensional Scene
   Filed: June 24, 2003
   Reel/Frame: 014537/0622
   Attorney Docket NO.: 09428/113002

2. **Patent Application/Serial No.:** 10/853,569
   Applicant(s): Gamal Shehab et al.
   Title: Array Seismic Fluid Transducer Source
   Filed: May 25, 2004
   Reel/Frame: 015728/0703
   Attorney Docket NO.: 09428/144001

3. **Patent Application/Serial No.:** 09/943,939
   Applicant(s): Cedric K R. H. Bouleau
   Title: Dynamically Modifiable User Interface
   Filed: August 31, 2001
   Reel/Frame: 012465/0406
   Attorney Docket NO.: 09428/183001

4. **Patent Application/Serial No.:** 09/755,002
   Applicant(s): Keith G. Kaan et al.
   Title: System, Method and Computer Program Product for a Universal Communication Connector
   Filed: January 5, 2001
   Reel/Frame: 011841/0075
   Attorney Docket NO.: 09428/184001

5. **Patent Application/Serial No.:** 10/426,352
   Applicant(s): Colin M. Sayers et al.
   Title: Method, Apparatus and System for Pore Pressure Prediction in Presence of Dipping Formations
   Filed: April 10, 2003
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